THE NATIONAL ACADEMIES
Advisers to the Nation on Science, Engineering, and Medicine

National Academy of Sciences
National Academy of Engineering
Institute of Medicine
National Research Council

FRONTIERS IN POLAR BIOLOGY

Planing Session
November 13, 2000

National Academies Main Building, Room 180
2101 Constitution Avenue NW
Washington, DC 20418

MONDAY, NOVEMBER 13, 2000

8:30 a.m.	Breakfast
9:00 a.m.	Donal Manahan (University of Southern California) – The Cold Biosphere: Introduction to the theme and goals for the meeting
9:20 a.m.	Bruce Sidell (University of Maine) – Physiological responses to life at low temperatures
9:40 a.m.	Jody Deming (University of Washington) – Exploring the genomics of polar organisms
10:00 a.m.	Break
10:15 a.m.	Jonathan Eisen (The Institute for Genomic Research) – Microbial genome projects: progress to date and future prospects
10:45 a.m.	Discussion
12:00 p.m.	Lunch
1:00 p.m.	Joseph Eastman (Ohio University) – Biodiversity and evolution of polar marine vertebrates and invertebrates
1:30 p.m.	Ken Nealson (California Institute of Technology, Jet Propulsion Laboratory) – Planetary microbiology: existence in extreme environments
2:00 p.m.	Brainstorming session
3:00 p.m.	Break
3:15 p.m.	What next?
5:00 p.m.	Adjourn meeting

Creating the Statement of Task

CREATING THE STATEMENT OF TASK

WHY IS THIS PRACTICE IMPORTANT?

The Statement of Task document tells an NRC study committee what that committee is supposed to accomplish. It must communicate what the National Academies Governing Board has approved as a study authorized by the institution and what the NRC has contractually agreed to do for the sponsor. It plays major roles in the study process from project initiation, to report development, to report review. A well-defined statement of task can aid the committee, the chair, and the study director at critical points throughout the process. A vague or unfocused statement of task is a factor most frequently identified as a cause of serious problems in completing a high-quality report on time and within budget.

SOME KEY PRINCIPLES:

1. The statement of task should be clear and definitive as to the purpose(s) of the project and the work that will be carried out to achieve this purpose. It should be explicit on what the product of the study will be, usually a traditional NRC report.

2. The statement of task should embody the general approach to the study, as outlined in the prospectus.

3. The statement of task should be general enough to allow leeway as to how the study will be carried out by the committee.

The following suggestions are useful in writing a statement of task that will serve its many functions well.

--In the prospectus, the purpose and specific objectives of the study may be described in the "Context" section rather than in the "Plan of Action." For the prospectus this organization may be appropriate, but the description of the purpose and objectives of the study should be extracted and used to introduce the task description in the stand-alone Statement of Task document.

--The statement of task should itemize subtasks the committee will perform as it progresses from information acquisition and analysis to report development. These subtasks can usually be succinctly stated and demarcated by using an enumerated or demarcated list of subtasks.

--The statement of task should make clear the technical approach or research methods the study will use and how the committee will acquire information on which it will base its findings. The research methods may be described within the list of subtasks or explained in a separate paragraph, as appropriate. These approaches and methods should derive from the prospectus.

--The statement of task should specify the result of the study. Typically this is a study report. If the report is expected to cover certain issues, they should be mentioned. Relevant

issues that are not to be addressed in the report or that are specifically excluded from the committee's purview should be noted.

How detailed or general should a statement of task be? The answer follows from the basic purpose of the statement of task as instructions to the study committee: there should be enough detail that members of the study committee will know what problem(s) they are to address and, generally, how to proceed in investigating it and arriving at consensus on conclusions and recommendations. The statement should be general enough to encompass the domain of information, expertise, and study activity needed to arrive at the best advice, on the issues posed for study, available from the technical and scientific community. It should be explicit about the product expected from the committee, usually a report.

Sample Statements of Task

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Polar Research Board
Commission on Geosciences, Environment, and Resources

Committee to Review NASA's Polar Geophysical Data Sets
Statement of Task

This study will review NASA's strategy for providing derived, geophysical data sets to the polar science community and, as an example, assess the strengths and weaknesses of the Polar Pathfinder data sets. The goal is to provide a brief review of the strategy, scope, and quality of existing polar geophysical data sets; suggest ways to make these products and future polar data sets more useful to researchers; and consider whether the products are reaching the appropriate communities effectively. The committee will:

1. Assess the general scope and quality of the polar data sets and determine whether, as a whole, these support the needs of the polar research community. This may include preparation of a matrix comparing existing data sets against the scientific objectives from NASA's Earth Science Enterprise program, which would help identify gaps and redundancies. It may also include consideration of the relationship of the data sets with data sets from other remote sensing operations, either in the United States or internationally, to indicate areas of overlap or potential cooperation.

2. Evaluate the strategy NASA used to develop and disseminate the polar data sets. Strategy means the approach used for creating and using the data sets, including size of project, location of maintenance, and whether processing is done at the home facility or by users, or some combination of these approaches, and related operational decisions.

3. Recommend improvements to NASA's strategy for providing the polar science community with data sets that support the goals of NASA's Earth Science Enterprise program, taking into consideration current capabilities, existing infrastructure, and cost-effectiveness. This might include consideration of changing computer technology and software, as well as accessibility of data and quality control of products.

4. As time and resources allow, evaluate individual polar data sets and products at the NSIDC and Alaskan SAR Facility to determine if they can be improved or modified to better support the community.

2101 Constitution Avenue, NW, Washington, DC 20418 *Telephone* (202) 334 3479 *Fax* (202) 334 1477 national-academies.org/prb

Statement of Task

Evaluation, Design, and Monitoring of Marine Reserves and Protected Areas in the United States

This project will examine the utility of marine protected areas, reserves, and harvest refugia for conserving marine biological diversity and living marine resources, including fisheries; compare the benefits and costs of this approach to more conventional management tools; and explore the feasibility of implementing such reserves. It will assess the scientific basis and the adequacy of techniques used for the location, design, and implementation of marine protected areas and reserves including the success of various types of harvest refugia for managing recreational and commercial fisheries.

The project will review the design, implementation, and evaluation of marine protected areas, using examples from the United States as well as Australia, New Zealand, Canada, and other countries where reserves have been implemented. The adequacy of current efforts to use marine protected areas and reserves, including harvest refugia, will be assessed both as a management approach for restoring declining fish stocks and as a tool for conserving marine biological diversity. The report will recommend ways to improve the implementation of marine protected areas and reserves, and will identify future research that could assist in implementing these tools more effectively.

Frontiers in Polar Biology Planning Meeting
Directions and Logistics

Hotel:
Holiday Inn Georgetown
2101 Wisconsin Avenue, NW
Washington, DC 20007
(202) 338-4600
Fax (202) 338-4458.

Meeting Location:
National Academies Main Building
Room 180
2101 Constitution Avenue, NW
Washington, DC 20418
(202) 334-2000

To get from the Holiday Inn to the Main Building, you will need to take the Academies' free shuttle. This leaves the courtyard between the Green and Harris Buildings of the Academies' Georgetown Facility (just south of the hotel) every 25 minutes.

To walk to the Green/Harris Facility from the Holiday Inn, turn left out of the Holiday Inn and walk down Wisconsin Avenue to Whitehaven Street (the next intersection). Cross Whitehaven, turn left, walk down past the large brick building and enter the driveway on your right. The shuttle buses will stop in this area. The buses are generally white and have NAS-NAE-IOM-NRC painted on them. If the shuttle proves inconvenient, you can take a taxi and be reimbursed.

Please note that on the way between the Georgetown Facility and the Main Building, the shuttle will make two stops.

If you are planning to attend the meeting and are not staying at the Holiday Inn, take Metro Rail to the Foggy Bottom Station. Come up the escalator and wait for the shuttle at the bus stop just to the left of the escalators.

A shuttle schedule and maps showing the shuttle stops are provided on the following pages.

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November 2, 2000

Memorandum

From: Susan Roberts, Program Officer

Chris Elfring, Director of the Polar Research Board

Subject: *Frontiers in Polar Biology* Planning Session

One of the roles of the National Academies is to look ahead and identify emerging scientific issues that might benefit from the careful discussion provided by the Academies' consensus study process. In this vein, on Monday, November 13, the Polar Research Board (PRB) will host a planning session to explore *Frontiers in Polar Biology*. The purpose of the planning session is to brainstorm on emerging issues in polar biology and highlight what we know and don't know about research needs in those areas. Participants will then be asked whether an Academy study, workshop, or other activity might help advance thinking about the issues and, if so, will outline questions to steer such an effort.

The planning session will be informal, in essence a brainstorming session that brings together a variety of scientists and program administrators (including some with polar experience and some without). We've invited six speakers to challenge our thinking, plus several members of the PRB and a number interested agency staff. The session will be led by PRB chairman Dr. Donal Manahan. The meeting will be held at The National Academies, 2101 Constitution Avenue NW, Washington DC (Room 180) from 9:00 a.m. – 5:00 p.m. An agenda for the meeting is included in this mailing.

Here are the types of questions we will address:

- From a biology perspective, what is unique about life at low temperatures?
- Is the metabolism of polar organisms as slow as predicted by thermodynamics?
- What types of adaptations facilitate life at low temperatures?
- Will genomics be helpful in identifying genes essential for life at low temperatures?
- What level of microbial and biogeochemical diversity exists in polar environments?
- What are the evolutionary relationships of polar organisms?
- How may communities in the cold biosphere be affected by climate change?
- Are there early ecological indicators of climate regime shifts?
- What, if any, types of unique evolutionary relationships are found in polar organisms?

We hope that you will be able to participate in this activity. Please contact Susan Roberts at the National Academies (sroberts@nas.edu or 202-334-1729) for further information or to reserve a space at the meeting if you have not already confirmed your attendance. A final copy of the agenda, participants list, background materials, and information about the Academies' regular free shuttle service from the Foggy Bottom Metro station will be included in a mailing sent to registered participants.

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Collection Samples

Pola- Biology

-Planning session

-Donald Manahan
-what is unique about life at low T°

Main points
-most of the living biosphere, by volume, is cold
-may or may NOT be majority of biodiversity
-accessing the cold environment not too hard
-water clear b/c low in particulate matter
-physiological challenges (e.g. starvation)
-how regulate metabolism
-change known processes
-invent new genes
-how use energy?
-very diff. in extreme environments
-turnover-rate for protein v. high (same as at high T°)
-similar concept in high T° (Amend + Shock 1998)

Bruce
-Southern ocean - cold for 10-14 my, collapse of species diversity 50M yrs ago
-lots O2, well mixed
-new features
-retention of features non-adaptive in other environ
two feature
-antifreeze glycoproteins prevent freezing
-derived from trypsinogen gene(s)

Population size?
Recombination?
Bottlenecks?

Other challenges
- reduction in kinetic energy
  - lower k_{on} / lower d. diffusion
- incr. in viscosity

How deal? Adaptation
- change protein flexibility
- change Mt density
- oxidation of Fe

How deal? Retention
- no circulating red cells / Hb
- huge hearts / volume // huge capillaries
- many also don't have Mb in heart
  - many diff. mutations do this
- suggests that Mb doesn't work at low T^o

How could

LGT
- touches about ecology

Microbial Genomics

Questions
- what is smallest genome size?
- how accurate is evolution?
- what are all these ORFs?
- how do organisms use gene duplication?

Practical problems
- costs
- databases
- people
- ethics
- international coordination

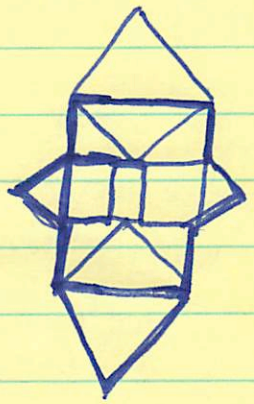
Polar Genomics
- Japanese effort?
- German effort?
  Soy reducing Arctic sediment
- US effort
  - colwellia - only genes where every member is cold adapted

Unique polar issues
Disease?? - more diversity of drug targets
Environment - radiation, C, other cycles, heat
Biodegradation
Evolution of psychrophily
  psychrophilic methanogen?

Deinococcus in SNOW.

Temperate deviation

- plasmids
- carboxydotherm -
- methylococcus -
- wolbachia - 1, 2



Collaborative efforts

- Research Coordination Networks
- Bioinformatics post doc fellowships
- Microbial observatories
- Integrative Research Challenges in Env Biology
- Biocomplexity - still developing sys. it will promote opportunities for people looking at genome info from environ. perspective
- Science + Tech Ctrs
- IGert?
- genome enabled research

- say NSF going to do best to incorp to Microb. genomics

NSF developing - agency wide math initiative including encouraging collaborations w/ other scientists

striking a balance betw. letting 1000 flowers bloom and having systems approach.

TISSUE LIBRARIES
GONA "
CONA "

from diff. organisms

SAMPLES

VOUCHERS

ANTARCTICA GENOMICS

Biodiversity + Evolution of Verts + Invert

Antarctica - underappreciated in evolution sense
- f(x) like an island

Antarctic shelf

- higher taxonomic diversity somewhat limited
- adaptive radiation
- suggests these are a species flock

Research needs
- documenting + naming species
  - Ross Sea - sponge beds + bank tops
  - Balleny Seamounts

taxonomy + systematics
- continue description
- useful + accessible to all

life history

geology

evolution
- phylogeny
- zoogeographic markers
- gene flow

K. Nealson -

- center for life detection

- diff. between prok + euks

  - time of planet
  - prokaryotes freq end up inside rocks in extreme environments
  - not surprising to find microbes all around the planet.

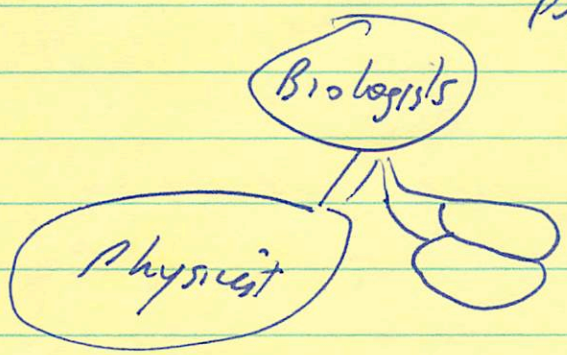
ARE MICROBES ENDEMIC

  - bacteria - usually don't do predation/phagocytosis

  ∴ compete by chemistry/metabolism/~~size~~

  - since they are small - they dominate biological surface area of planet

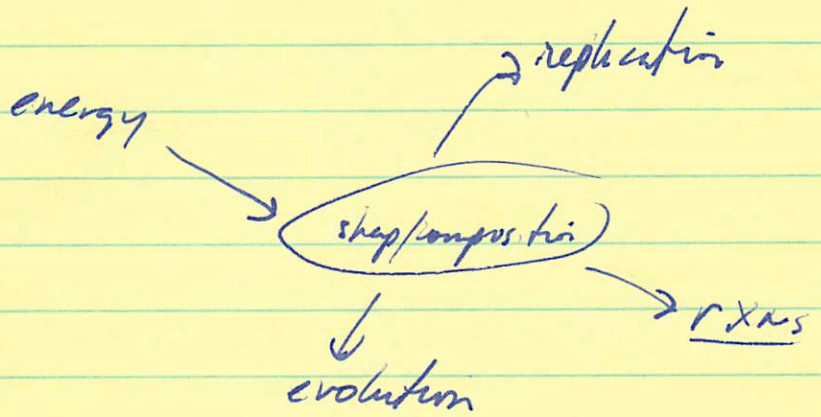
Predator-prey



Photoprophs
Plants
Algae

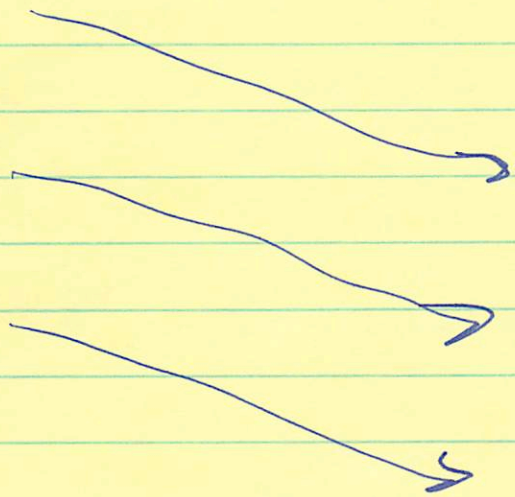
CHEMIST

life detection



FUELS

OXIDANTS



↓P slopes down
then could be
e⁻ source

LIFE IS KINETICS

- life is competing w/ spontaneous rates of RXNs
- will try to make catalysts for RXNs that occur at mid speeds

NEEDS

Explore + collect

Taxonomy + Systematics

chemical roles

unknown genes

uncultivable organisms

- what is unique about

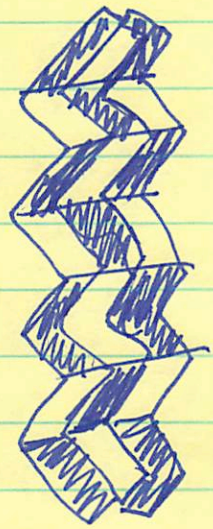
- is there unique life at low T°? photoperiod? — individual, systems, ecology
  - functional genomics
  - how to move the field forward

- developing specimen repositories — climate change, populations

- systematics approach vs 1000 flowers

- are there roadblocks to moving the field forward
  - Data availability
  - instrumentation/sequencing
- what are the needs of polar researches?

- lack of respect



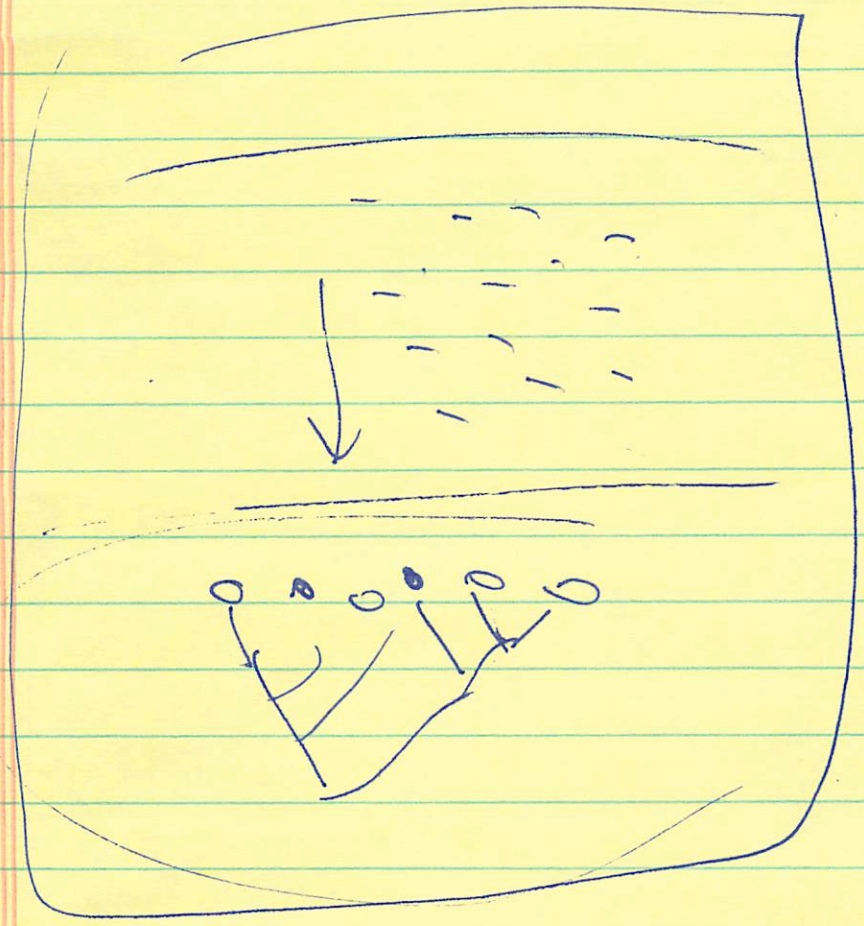
- ACADEMY STUDY

- interdisciplinary

- Genomics/Phys/genomics of environment
- Ecological genomics
-

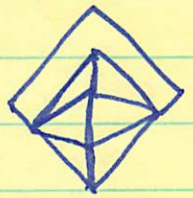
Cold adaptation at molecular level

Many times should get job at NAS/HHMI.



- unique opportunities to study biology

- proteins are more flexible



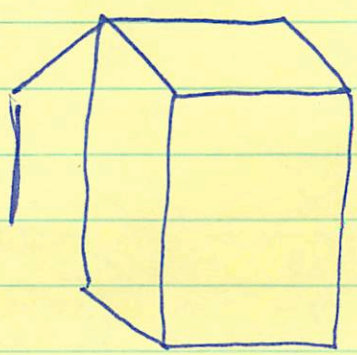
- fundamentals
  - protein structure/flexibility
  - adaptive radiation
  - phylogeography
  - evo-devo at low T°
  - photoperiodism/life strategies/overwintering

convergence
- low nutrients/low light
- climate change
- episodic resources
- compare to desert

- nutrient cycles
- viscosity/solubility
- cold stress/heat stress

- modeling annual cycles
- cycles vs. generations

VBeck
NAR
GR



Polar Biology I

Why an academy study?

- national/international ~~study~~ importance
- opportunity to IDnew areas
- shared sense of direction
- multidis. integration

LEXEN
BIOCOMP
MICROOBS

Who is the audience?

Biology of Global change

- can culture 60% of what's there in sea ice.